

I – Problem Statement Title (04-GS048)

Evaluation of Hollow Bar Soil Nail Systems for Excavation Reinforcement

II – Research Problem Statement

Question: What is the reliability of hollow bar soil nail systems for permanent excavation support?

The use of conventional soil nail systems for slope stabilization and excavation support poses difficulties when ground conditions are subject to caving. This situation happens for granular soils such as silty sand (sugar sand) or cobbles and boulders. The use of casing to prevent caving for these soil conditions is costly and the slow process delays project delivery. One representative Caltrans project was the Visalia project in Tulare County in which twelve soil nail walls were constructed. The silty sand deposits at the site caused drilled holes to cave and led to extensive construction disputes. Finally, the decision was made to use a hollow bar system for this project in order to overcome the caving problems. Currently, hollow bar systems (as defined in the background section) are not approved by Caltrans as a permanent system for slope stabilization and excavation support due to lack of understanding of their behavior and concerns over the long-term performance (i.e., corrosion issues) of these reinforcing systems.

III – Objective

The objective of this research is to evaluate the behavior of hollow bar soil nail systems in the field. The specific goals are to understand (a) the level of damage to the bar caused during installation, (b) the grout geometry along the length in different soil conditions; and (c) compare the load carrying capacity with the conventional soil nail systems.

IV – Background

Caltrans has extensively used soil nailing technology for excavation support and reinforcement of steep slopes and vertical walls for over a decade. Soil nailing is a “top-down” construction process that consists of a soil slope excavated to a vertical, or near-vertical orientation internally supported by closely spaced steel reinforcing bars fully grouted in place.

The hollow bar system, also known as Injection boring (IBO) rod, was originally developed in Germany. Unlike a conventional soil nailing operation, the hollow bar system combines both drilling and grouting in a single operation. A hollow steel bar serves as the drill rod as well as reinforcing material; and cement grout as the drilling, flushing and stabilizing fluid.

V –Statement of Urgency and Benefits

A. Support of the Department's Mission/Goals:

(Improving Mobility: Safety, Reliability and Productivity) There is increase potential risk of caving in the standard excavation method that may impact the stability of the excavated area. This may cause human injury and interruption of traffic due to ground settlement behind the excavation. This method eliminates the hole by using sacrificial drilling bit and injecting grout into hollow bars that are left in-place as part of the permanent system. Accordingly, the wall will be more reliable due to (a) improved stability by eliminating open hole; and (b) using an injected system, rather than a bored hole filled with grout.

B: Return on Investment:

Evaluation of hollow bar systems in the field will enable Caltrans to incorporate into practice an innovative European technology that reduces construction time and construction cost. Over the past 13 years, more than 2 million square feet (185,800 m²) of soil nailed walls have been constructed in California alone, with Caltrans projects directly (or indirectly, because of consultant-designed projects under locally funded measures) accounting for the vast majority. Savings associated with reduction in construction time and construction cost are estimated to be in the millions of dollars.

Caltrans can use the results of this study for new design and design changes, construction conflict resolution, construction changes, communication with outside agencies and other State DOT's, and dissemination of new developments in the soil nail technology.

VI – Related Research

Some research work has been performed in Europe, however, the work was funded by the manufacturers of hollow bar systems. Utah DOT may also have some limited data. Caltrans has some data from Visalia project.

VII – Deployment Potential

The findings of this study will provide the opportunity for Caltrans engineers to see if hollow bar technology can be used for permanent soil nail systems. This will lead to reliable design of excavation support and reinforcement of steep slopes adjacent to highways and reduces the problems associated with construction claims and litigation.